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A MONOGRAPH OF THE NATIONAL SPACE TRANSPORTATION SYSTEM OFFICE (NSTSO) INTEGRATION ACTIVITIES CONDUCTED AT THE NASA LYNDON B. JOHNSON SPACE CENTER FOR THE EASE/ACCESS PAYLOAD FLOWN ON STS 61-B

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ABSTRACT

The integration process of activities conducted at the NASA Lyndon B. Johnson Space Center (JSC) for the experimental assembly of structures in extravehicular activity (EASE)/assembly concept for construction of erectable space structures (ACCESS) payload is provided as a subset to the standard payload integration process used by the NASA Space Transportation System (STS) to fly payloads on the Space Shuttle. The EASE/ACCESS payload integration activities are chronologically reviewed in this paper beginning with the initiation of the flight manifesting and integration process. The development and documentation of the EASE/ACCESS integration requirements are also discussed along with the implementation of the mission integration activities and the engineering assessments supporting the flight integration process. In addition, the STS management support organizations, the payload safety process leading to the STS 61-B Flight Certification, and the overall EASE/ACCESS integration schedule are presented.

INTRODUCTION

The role played by JSC in the integration of the EASE/ACCESS payload was to document and coordinate the implementation of the payload technical and scientific requirements. This effort was the responsibility of the National STS Office (NSTSO) with other JSC organizations furnishing various levels of technical and operational support during the preflight integration, flight, and postflight periods. This paper is a summary of the participation by JSC in the total integration process for EASE/ACCESS payload. Details of specific integration support activities, such as training and crew activities, and associated results appear elsewhere in other papers and discussions presented at this conference.

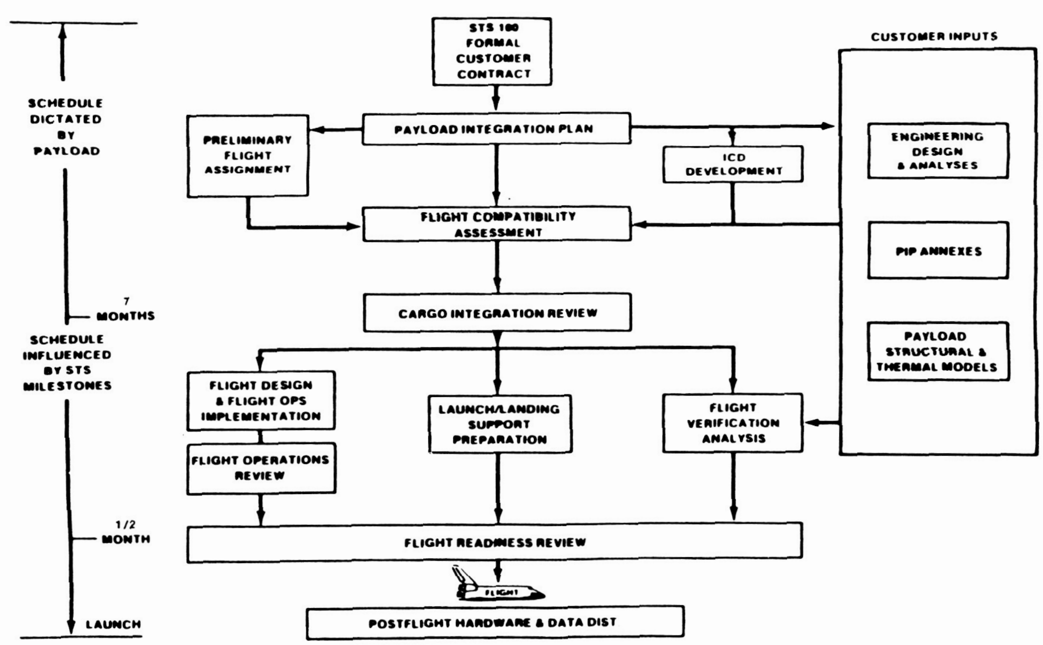
THE STS INTEGRATION FLOW FOR THE EASE/ACCESS PAYLOAD

On December 14, 1983, the NSTSO at JSC received from NASA Headquarters a memorandum and the EASE/ACCESS Request for Flight Assignment Form (NASA STS Form 100) authorizing the technical payload integration process to begin. The Headquarters Customer Services Office memorandum containing the NASA STS Form 100 was also forwarded to NASA John F. Kennedy Space Center (KSC), advising KSC payload integration personnel to also prepare for the technical integration of the EASE/ACCESS payload. Upon receipt of the EASE/ACCESS NASA STS Form 100 at JSC, the Flight Assignment Working Group (FAWG) began investigating manifesting opportunities for a flight for the EASE/ACCESS payload. The NASA STS Form 100 requested that EASE/ACCESS be manifested on a specific flight (STS-25) in the summer of 1985. Because of numerous manifesting problems (e.g., satellite deployment failures on STS 41-B and 51-D, satellite retrieval mission priorities on STS 51-A and 51-I, etc.) the EASE/ACCESS payload was preempted from its originally requested flight and finally manifested on STS 61-B (STS-31 under the previous STS accountability system for numbering space flights). The flow of the EASE/ACCESS payload integration activities at JSC started with the receipt of the NASA STS Form 100 and can be followed on the overview chart shown in Figure 1.

After having received the EASE/ACCESS NASA STS Form 100 at JSC, the NSTSO management assigned the author of this paper as the Payload Integration Manager (PIM) for the EASE/ACCESS payload. The PIM served as the primary technical point of contact for the NASA George C. Marshall Space Flight Center (MSFC) Spacelab Payload Program Office (SPPO) throughout the integration process, from the initial contact meeting, during the flight, and through postflight activities. The PIM was responsible for ensuring the technical requirements had been accurately defined and documented, were compatible with the Orbiter's payload accommodations, and were properly implemented. The author also served as coordinator for all payload engineering and other technical support activities which were required to integrate the EASE/ACCESS payload at JSC.

Technical integration of the EASE/ACCESS payload began with an introductory NSTSO payload integration meeting conducted with MSFC SPPO personnel at JSC on January 26, 1984. Key flight operations and engineering personnel from the NSTSO, and from other organizations that support the STS payload integration process, discussed and negotiated the technical integration requirements for EASE/ACCESS. All of the technical requirements and agreements required to integrate the payload into the STS were documented in the EASE/ACCESS Payload Integration Plan (PIP), JSC 18436. As part of the EASE/ACCESS PIP, an integrated STS/payload schedule was negotiated and agreed to. The dates when major STS integration milestones were achieved and when EASE/ACCESS integration documentation was baselined are shown in Figure 2. Additional detailed requirements and agreements, including the EASE/ACCESS launch and landing site requirements, are documented in the EASE/ACCESS seven annexes (annexes 1, 2, 3, 6, 7, 8, and 11) to the EASE/ACCESS PIP. A brief summary of the content of each of these annexes

PAYLOAD INTEGRATION PROCESS OVERVIEW



is discussed in the following paragraphs. Although documented separately, these annexes are considered an extension of the payload technical requirements definition and are considered an adjunct to the approved EASE/ACCESS PIP.

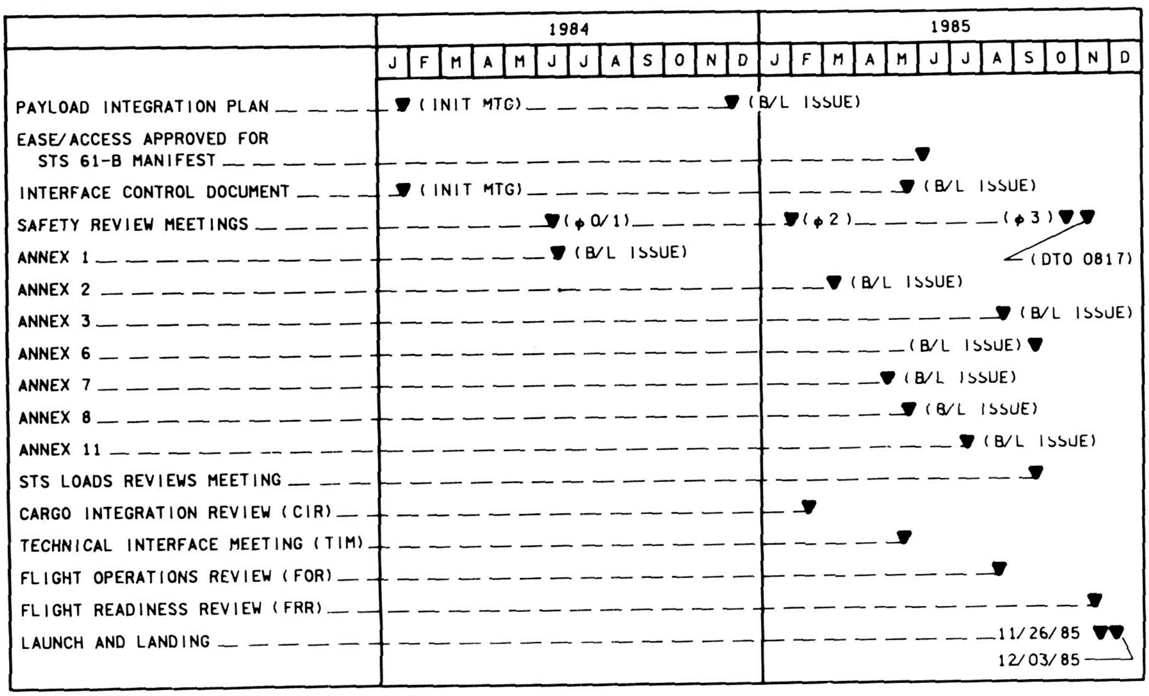
ANNEX 1 - PAYLOAD DATA PACKAGE

The Payload Data Package Annex provided detailed data on the physical characteristics of the EASE/ACCESS payload including defined weights, center of gravity data, sequenced mass properties, and the configuration and dimensional data of the payload in both the stowed and erected configurations for the EASE and for the ACCESS experiments.

ANNEX 2 - FLIGHT PLANNING

The Flight Planning Annex contained the required flight design and crew activity requirements for the EASE/ACCESS payload. The annex comprised two sections: the flight design section containing information on Orbiter equipment usage such as still and motion cameras, remote manipulator system (RMS) video system, cargo bay lights, one aft and two forward cargo bay closed circuit television (CCTV) cameras, and three aft flight deck CCTV video tape recorders (VTR's). The flight activities planning section contained payload scheduling data which was used to develop the STS 61-B Crew Activity Plan (CAP) and included EASE/ACCESS experiment timeline data, EASE/ACCESS payload scheduling constraints, and crew payload support requirements.

EASE/ACCESS PAYLOAD INTEGRATION ACTIVITIES SCHEDULE



BASELINE (B/L)
PHASE (φ)

ANNEX 3 - FLIGHT OPERATIONS SUPPORT

The Flight Operations Support Annex documented the SPPO inputs for on-orbit EASE/ACCESS payload flight control operations and procedures. Specifically covered were the EASE/ACCESS payload operations support plan, the payload flight operations decisions, payload operations procedures, payload malfunction procedures including contingency jettison, and the EASE/ACCESS science data collection requirements and constraints.

ANNEX 6 - ORBITER CREW COMPARTMENT

The Orbiter Crew Compartment Annex provided a detailed description of the EASE/ACCESS payload items to be installed in the Orbiter crew compartment. The equipment description included individual part numbers, quantities, size, weight, and usage requirements of the EASE/ACCESS hardware items which affected its crew compartment stowage location, crew physical access, and the crewmember handling of the equipment.

ANNEX 7 - TRAINING

The Training Annex documented a training schedule and a description of the payload-unique EASE/ACCESS payload training activities. It included the EASE/ACCESS training that the SPPO required of the STS mission specialists and the training required to satisfy the SPPO payload experimenter science requirements. These EASE/ACCESS training requirements were integrated with the Space Shuttle specific premission training activities to schedule the EASE/ACCESS payload training when STS crewmembers were available.

ANNEX 8 - LAUNCH SITE SUPPORT PLAN (LSSP)

The Launch Site Support Plan Annex contained data for planning launch site processing of the EASE/ACCESS payload. The plan was a commitment of launch site facilities, support equipment, and services to the SPPO for a given time period to conduct assembly, test, and checkout of the EASE/ACCESS payload. A KSC Launch Site Support Manager (LSSM), assigned to the EASE/ACCESS payload, prepared the LSSP after having received the MFSC-SPPO-provided EASE/ACCESS Ground Integration Requirements Document (GIRD) and after coordinating and negotiating the requirements documented in the LSSP with the SPPO.

ANNEX 11 - EXTRAVEHICULAR ACTIVITY (EVA)

The Extravehicular Activity Annex defined the payload-unique EVA interface requirements for both planned and contingency EASE/ACCESS flight operations. The EASE/ACCESS requirements included a definition of all physical, functional, and environmental interfaces. Physical interface data for the EASE/ACCESS payload consisted of items such as payload and experiment geometry, hardware dimensions, EASE/ACCESS placement location in the Orbiter cargo bay, payload equipment weights, forces, etc. Functional data included both EASE and ACCESS experiment task definition and time requirements. The EASE/ACCESS environmental interface data documented such things as thermal surface temperature constraints, Orbiter vehicle orientation constraints, etc. Also included in the EVA Annex was information on EVA crewmembers translation paths, crew worksite interface requirements, EASE/ACCESS payload contingency jettison, payload markings and decals, cargo bay EVA support equipment stowage for the EASE/ACCESS payload, and the mission scenarios for both EVA's.

Once the technical integration requirements and agreements had been reviewed, negotiated, and agreed to by both the SPPO and the NSTSO, the EASE/ACCESS PIP became the overall payload technical requirements contract. The development process for the documentation of the detail requirements in the EASE/ACCESS PIP annexes was different from the PIP development process in that the MSFC SPPO provided the initial data submittal of the preliminary EASE/ACCESS annexes which were then reviewed by various designated STS PIP annex managers. The EASE/ACCESS annex managers separately negotiated each annex, fitting the EASE/ACCESS payload science and technical requirements to STS capabilities. The EASE/ACCESS PIP annexes were formally baselined (exception - annex 8) in the same manner as the EASE/ACCESS PIP and represented part of the STS-to-EASE/ACCESS technical contract. Once signed and baselined, all subsequent changes to either the EASE/ACCESS PIP or to the PIP annexes were then covered by STS configuration management control (exception - annex 8). All technical changes were formally submitted to the JSC NSTSO Mission Integration Configuration Review Board. Approval of either EASE/ACCESS PIP or PIP annex technical changes by both the MSFC SPPO and the STS management at JSC was required prior to change implementation by the STS.

The EASE/ACCESS integration process also included payload interface discussions and negotiations of the payload-to-STS physical interface definition, EASE/ACCESS payload flight interface loads, and EASE/ACCESS equipment clearances. The first interface discussions were initiated in a meeting on January 27, 1984, the day following the initial EASE/ACCESS PIP meeting. Conducting a payload-to-STS Interface Control Document (ICD) meeting prior to the signing and baselining of the EASE/ACCESS PIP was employed as a trial method for initiating ICD activities with future STS payloads. Although this early start for the development of the EASE/ACCESS ICD was successful, the concept of early initiation for preparation of ICD's is no longer used by the NSTSO for cargo bay payload ICD development. At present, all cargo bay STS-to-payload ICD discussions and related activities are initiated only after the specific payload technical requirements are well understood and agreed to (e.g., after the payload PIP has been signed). The EASE/ACCESS ICD was subsequently signed and baselined on May 23, 1985.

In addition to the standard cargo bay STS-to-payload interfaces, the EASE/ACCESS extravehicular activity (EVA) STS 61-B mission required unique tools to be used in support of both the EASE and the ACCESS experiments. These tools were stowed in the Orbiter provisions stowage assembly (PSA) containers located in the cargo bay. The stowage allocation for the EASE/ACCESS tools on the STS 61-B mission was negotiated between the NSTSO and the STS Orbiter and Government Furnished Equipment (GFE) Project Office, and documented in a formal Change Request (G-1635, approved July 8, 1985) presented to the JSC Orbiter Flight Equipment Configuration Management Review Board. The method and stowage location of the EASE/ACCESS tools were documented on the STS 61-B Mission PSA Assembly Drawing (M072-661633-020) and were not included as part of the EASE/ACCESS ICD-A-18436.

Further, EASE/ACCESS payload crew cabin stowage was also utilized to stow the extensive amount of video cassette, photographic film, and camera equipment required to document the EASE/ACCESS scientific data collected during the two STS 61-B EVA's. Two stowage lockers in the Orbiter crew compartment middeck were allocated to accommodate all of the EASE/ACCESS cassette, film, and camera equipment stowage. The EASE/ACCESS stowage locker allocation was used to stow 57 CCTV video cassette tapes (1 additional cassette tape was stowed inside each of the 3 dedicated video tape recorders), 6 rolls of 16 mm movie film, 1 role of 70 mm film and miscellaneous ancillary camera equipment items.

During the PIP and PIP annex development process, the safety process for the EASE/ACCESS payload was concurrently being developed. It is the responsibility of the STS to establish the safety requirements for all flight payloads and to ensure that all payload safety hazards identified by the customer are properly controlled to meet the established STS safety requirements. Safety is of paramount importance to the STS and is an ongoing iterative process that is integral to all payload/STS integration activities. The following reference documents define the ground and the flight technical and system safety requirements for the EASE/ACCESS payload.

Space Transportation System Payload Ground Safety Handbook, KHB 1700.7

Safety Policy and Requirements for Payloads Using the Space Transportation System (STS), NHB 1700.7A

Implementation Procedure for STS Payloads System Safety Requirements, JSC 13830A

STS Payloads Safety Guidelines Handbook, JSC 11123

Interpretations of STS Payload Safety Requirements, JSC 18798

The beginning of JSC's involvement with the EASE/ACCESS payload safety activities was initiated with a payload conceptual design meeting held at JSC on December 7, 1983. The meeting was held to discuss EASE/ACCESS physical design and operational concepts with safety, astronaut, payload program office, mission operations, and training personnel. Equipment failures that could cause in-flight hazards or safety concerns with the payload were discussed and proposed solutions were provided to the EASE/ACCESS experiment hardware design team to explore during development of their payload. Also included in the discussion was the methodology of a payload component jettison should failure of an EASE/ACCESS component preclude its safe stowage for Orbiter landing. Although the meeting was not considered part of the formal payload process, it did result in safety-related operational and design agreements which served to establish, in part, the basis for the formal EASE/ACCESS payload safety data package submittal from the MSFC SPPO.

The EASE/ACCESS payload safety program was the responsibility of the SPPO and, to this extent, the SPPO was responsible for ensuring that the EASE/ACCESS hardware, including the ground support equipment (GSE), complied with the requirements stated in the previously listed safety documents. This responsibility included the identifying, reporting, and resolving of any possible EASE/ACCESS safety hazards, as well as certifying preflight to the STS 61-B Flight Readiness Review (FRR) Board that the EASE/ACCESS payload was safe to install into the Orbiter and to fly on that mission.

The JSC Safety Review Panel, made up of both technical and operational personnel from disciplines such as mission operations, Orbiter payload integration, payload safety, engineering, ground operations, and life sciences, conducted all three of the phased EASE/ACCESS flight safety reviews. During the reviews all aspects of the payload equipment design and flight operations were reviewed. The depth and number of formal safety reviews for the EASE/ACCESS payload were determined by the STS Safety Review Panel chairman in conjunction with the mission manager from the SPPO and depended on the potential and complexity of the safety hazards involved and the technical maturity of the SPPO safety documentation to support control and closure of the EASE/ACCESS hazards. The date of occurrence and the primary objectives of each of the EASE/ACCESS safety reviews were as follows.

PHASE	DATE	REVIEW OBJECTIVES
0/1	6/19/84	To identify all EASE/ACCESS safety-critical hazards and applicable safety requirements for subsystems, to assess the implementation approach to each hazard control along with the development of an understanding of verifying the approach by the SPPO for the control of each of the EASE/ACCESS hazards.
2	1/31/85	To verify the EASE/ACCESS payload design compliance with the safety hazard requirements and review each of the SPPO hazard verification methods.
3	10/23/85*	To review all of the EASE/ACCESS hazards, to ensure completion of all SPPO safety verification activities, and to agree that all safety activities for the EASE/ACCESS payload have been satisfactorily completed.

* The MSFC SPPO EASE/ACCESS payload safety package data submittal was reviewed by the JSC Payload Flight Safety Panel without conducting a formal meeting. The date shown reflects the formal Phase 3 safety approval by the JSC Safety Panel in an NSTSO letter to the MSFC SPPO agreeing that control and closure of all EASE/ACCESS flight hazards had been satisfactorily accomplished by the SPPO.

The JSC Orbiter and GFE Project Office provided the Certification of Flight Safety and Readiness for the stowage of the EASE/ACCESS support tools and equipment in the STS 61-B mission cargo bay PSA's.

To support the implementation of the EASE/ACCESS PIP requirements and the safety development process a number of specific engineering assessments were conducted by the STS on the EASE/ACCESS payload. Summary information for each of the engineering assessments is listed as follows.

THERMAL ASSESSMENT

Because the EASE/ACCESS payload had no electrical-heat-generating equipment, only a minimal thermal engineering assessment was conducted by the STS on the EASE/ACCESS payload. The purpose of the assessment was to ensure that the known design surface properties of the EASE/ACCESS payload components would not exceed a safe touch temperature for the EVA crewmembers during EASE/ACCESS activities. For the STS 61-B mission, the Space Shuttle thermal working group did conduct an integrated STS/payload thermal assessment on the combined effects of all the payloads in the cargo bay using payload-supplied thermal data in place of a completely integrated STS/payload mission analysis.

STRUCTURAL ASSESSMENT

An STS structural loads assessment was conducted for the EASE/ACCESS payload for its specific STS 61-B cargo bay location. The STS assessment was based on various dynamic transient and quasi-static load conditions of the Space Shuttle. The structural assessment was completed using a structural loads math model of the EASE/ACCESS payload in the stowed position; the math model had been provided to the STS by the SPPO. The STS used a coupled loads analysis for the STS 61-B cargo mix to determine the maximum expected flight interface loads and relative deflections for the various load conditions. The EASE/ACCESS payload was required to be compatible with the resulting loads and deflections. An STS 61-B Loads Verification Review was conducted by the Space Shuttle structural working group with EASE/ACCESS personnel on September 26, 1985, to review the structural compatibility of all of the STS 61-B cargo bay payloads.

ELECTROSTATIC CHARGE ASSESSMENT

On each of the two STS 61-B EVA's, the crewmembers were to assemble and disassemble EASE/ACCESS components which were made of different interface surface material compositions. NSTSO management personnel expressed a safety concern that the potential for an electrostatic charge buildup on the component frictional interfaces could occur, and, in combination with a hydrogen leak in the cargo bay during the reentry and landing phase, may be sufficient to cause an explosive situation to occur. Therefore, the potential for an electrostatic charge accumulation during EASE/ACCESS on-orbit activities was assessed in detail. It was determined from the assessment that, because of a lack of a credible charging mechanism, only an extremely small charge potential could be built up by the crewmembers during the EVA's from the friction between the EASE/ACCESS components moving relative to one another and that it produced insufficient arc potential for an in-flight hazardous condition to occur.

VIDEO TAPE RECORDER ASSESSMENT

Because of the lengths of constant on-time that the Orbiter VTR's were scheduled to operate during each of the two planned EVA's, an assessment was made to see if VTR's available from previous mission accommodations could be used to support the EASE and the ACCESS data collection along with the STS-required EVA egress and ingress overhead recording times. The assessment concluded in summary that because of their design, the operation of the three VTR's required to support EASE/ACCESS data collection may become marginal at the end of each of the two mission EVA's. The decision by both the SPPO and NSTSO personnel to accept the minimal risk was based primarily on not having any acceptable flight qualified VTR's to use as substitutes on the STS 61-B flight, and the development time and costs associated with qualifying new VTR's.

ON-ORBIT FLIGHT CONTROL/INDUCED LOADS ASSESSMENT

JSC, with the responsibility for flight control activities, made a study to investigate the interaction between the EASE and the ACCESS erected structures and the on-orbit control of the Space Shuttle Orbiter. The study was performed by the Charles Stark Draper Laboratory, Inc. of Cambridge, MA, for JSC using a computerized simulation containing the Space Shuttle Orbiter flight control model and the structural math models of both the EASE and the ACCESS experiment hardware in their fully erected stages. Both the EASE and the ACCESS math models were provided to Draper Labs by the MSFC SPPO. The results of the study were used to develop several of the STS 61-B mission flight rules, specifically those flight rules protecting the Space Shuttle Orbiter during the on-orbit period of EASE/ACCESS payload activities. The use of the flight rules served as hazard controls to preclude exposing the crew and the Orbiter to hazardous conditions in flight which may have developed from excessive flight control induced loads on the erected experiments during the EASE/ACCESS payload activities.

COMPUTERIZED VIEWING ASSESSMENT

To assure adequate equipment clearances for the crew during the EASE/ACCESS EVA operations and for the EASE/ACCESS scientific data collection, a computer aided design/computer aided engineering (CAD/CAE) Orbiter cargo bay camera assessment was conducted. The CAD/CAE data provided prospective computerized displays of the EASE/ACCESS payload and the EVA crewmembers from the various Orbiter camera locations, simulating photographic and CCTV data collection through the Orbiter aft flight deck windows and from the cargo bay bulkhead and RMS cameras. Simulations of minimum and maximum viewing angles from the cameras including zooming capability for the various camera lens systems planned for use on the STS 61-B flight were performed. Simulated views looking at the EVA crewmembers hands, patches placed on the crewmembers EVA suits, and for the EVA crewmembers at each of the EASE/ACCESS permanent workstations and in the manipulator foot restraint (MFR) were provided to the SPPO to augment their hardware design. In addition, the CAD/CAE simulated EASE/ACCESS payload movement in the Orbiter cargo bay to see if conflicts in camera viewing existed while the EVA crewmembers were accomplishing the EASE/ACCESS activities.

CARGO ENGINEERING ASSESSMENT

In support of the STS verification of a customer's documented requirements, a cargo engineering assessment was made prior to the formal Cargo Integration Review (CIR) for the mission. This engineering assessment is performed by various NASA JSC and KSC organizations and by the JSC payload integration support contractor, Rockwell International, of Downey, CA. The payload documentation inputs and organizations that participate in the integrated mission cargo engineering assessment and the flight products produced as a result of the integrated cargo assessment are shown in Figure 3. The results of the cargo engineering assessment determined the compatibility of the EASE/ACCESS payload with the Orbiter and other payloads on board the STS 61-B flight. Following this assessment, cargo engineering drawings and documents called flight products were finalized, signed, and placed under configuration management control. The mission flight products were assessed for all payloads and included specific information on EASE/ACCESS payload specific installation drawings and removal instruction details, EASE/ACCESS-to-Orbiter integration hardware, EASE/ACCESS integration hardware placement and definition, and any other products required to implement the cargo manifest and to ensure cargo compatibility.

In addition to the various engineering assessments conducted to validate the EASE/ACCESS integration activities into the STS, the EASE/ACCESS payload required further integration support activities to ensure that the science data requirements could be accommodated. Selection of the cargo bay CCTV camera lens for each of the cameras was reviewed to ensure an acceptable compatibility with all mission requirements. Because the JSC Orbiter and GFE Project Office were qualifying a new 16 mm movie camera system for flight, the EASE/ACCESS requirement to have stereoscopic viewing by two synchronized 16 mm movie cameras was added to the purchase of new flight cameras being procured by the STS. The camera changes such as shutter lens modification, synchronization of camera frames between two cameras, and applying a time code of HR/MIN/SEC to each film frame were successfully completed and tested. A test of the modified camera system was conducted in the JSC one-g flight trainer to verify camera synchronization operations and film exposure prior to the mission to ensure compatibility with EASE/ACCESS science requirements.

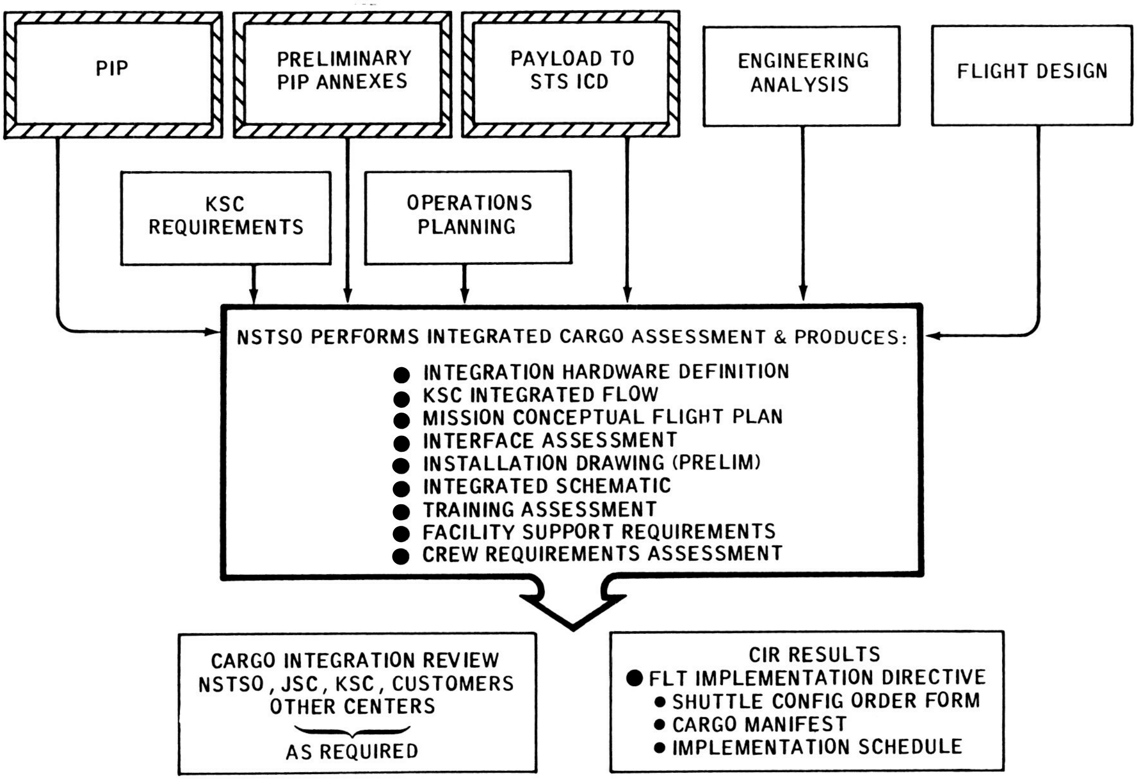


Figure 3

The EASE/ACCESS science data were collected on Eastman Kodak 5017 ASA64 photographic film from an STS version of a 70 mm Hasselblad model 500 ELM camera. CCTV tapes were 3/4-inch U-Matic format cassette tapes and the 16 mm movie film was Eastman Kodak 852 ASA 400 thin base color film used in the two modified Arriflex model 16 SRII cameras. For the 16 mm movie film photography tradeoffs such as the types of film to be used versus modified camera lens system for Orbital day/night exposure cycles versus available STS GFE camera lens systems were performed to provide optimum EASE/ACCESS photographic science data collection.

The total amount of still and movie film, CCTV cassette tapes, and the ancilliary camera equipment used to document the EASE/ACCESS scientific data were agreed to and documented in the EASE/ACCESS PIP and the EASE/ACCESS Crew Compartment Annex (annex 6). The postflight EASE and ACCESS experiment photography, CCTV cassettes, film and color conversion requirements, and the product delivery requirements requested by the MSFC SPPO were documented in a letter from the SPPO to the JSC Photographic Laboratory.

EASE/ACCESS crew training for the STS 61-B mission is the subject of another paper to be presented in detail at this conference. It is appropriate to mention in summary that a major portion of the preflight procedure development and EVA crewmember training on the EASE/ACCESS payload did occur at the MSFC during three EASE/ACCESS neutral buoyancy tests. NSTSO programmatic support for the EASE/ACCESS tests consisted of providing direction and requirements to the JSC Orbiter and GFE Project Office to ensure that the necessary JSC technical personnel and properly configured equipment participate in each of the three MSFC tests before, during, and after the STS 61-B flight crew training.

With the completion of the development and the agreement of the EASE/ACCESS flight, training, and mission support requirements, formal verification of the requirements was performed through participation by the MSFC SPPO personnel in several formal STS reviews. A summary of each of these reviews is subsequently presented.

The EASE/ACCESS payload interface compatibility and the operational and safety requirements were verified at several STS Cargo Integration Reviews (CIR's) prior to the final manifesting assignment on STS 61-B. Because EASE/ACCESS was considered a somewhat inert payload (e.g., no power, cooling, or data requirements) and had been fully assessed in previous CIR reviews, the NSTSO made the decision not to hold another CIR or a Delta CIR on the STS 61-B mission after the flight manifest had been changed to include the EASE/ACCESS payload. Instead, a formal configuration change directive was reviewed and approved by STS personnel and was sent by the NSTSO to all JSC and KSC STS support organizations defining the overall cargo mission requirements and the scenario of the planned STS 61-B flight activities. The STS 61-B cargo complement and the cargo bay flight payload configuration are shown in Figure 4. The STS support organizations that had previously provided CIR assessments on the EASE/ACCESS payload requirements incorporated the EASE/ACCESS requirements into the STS 61-B flight products and proceeded to develop the necessary flight implementing documentation required to support the STS 61-B mission. The STS change directive provided the proper authorization for the STS 61-B cargo mix changes, and a normal review and engineering release process for the STS 61-B flight products followed. Typically the Cargo Integration Review

(CIR) is the first of the payload requirements verification reviews in which a customer participates. The CIR's are conducted to ensure that all mission payloads can physically and functionally be integrated into a flight which is within the STS flight and ground capabilities. The CIR establishes the baseline of the flight event sequence and provides the payload organizations an opportunity to review their payload requirements at the cargo/flight level. The typical flow of cargo compatibility activities leading to the CIR and the implementing authorization are summarized in Figure 3. The individual mission CIR's are chaired by the NSTSO manager at JSC with board members from the STS elements and the payload customers. The results of the CIR provide the implementing organizations with the basic engineering, operations, and support baseline to initiate the flight and ground implementing activities.

A payload technical interface meeting (TIM) was held on May 16 and 17, 1985, to review the EASE/ACCESS operation annexes (annexes 3 and 11) and the training annex (annex 7). Also included in the agenda were detailed discussions of the STS camera configuration, the EASE/ACCESS photography scene requirements, and the types and quantity of film to be used to collect the science data for both the EASE and the ACCESS experiments. The RMS support requirements and the EASE/ACCESS Space Station Assembly Test Detail Test Objective (DTO 0817) were also discussed in detail. Persons attending the meeting included the experiment principal investigators for both the EASE and ACCESS experiments and their associated management and technical personnel from the MSFC SPPO, Langley Research Center, and the Massachusetts Institute of Technology. JSC was represented by personnel from the operations and training divisions, the STS 61-B flight crew, camera and RMS equipment systems managers, and the NSTS Program Office.

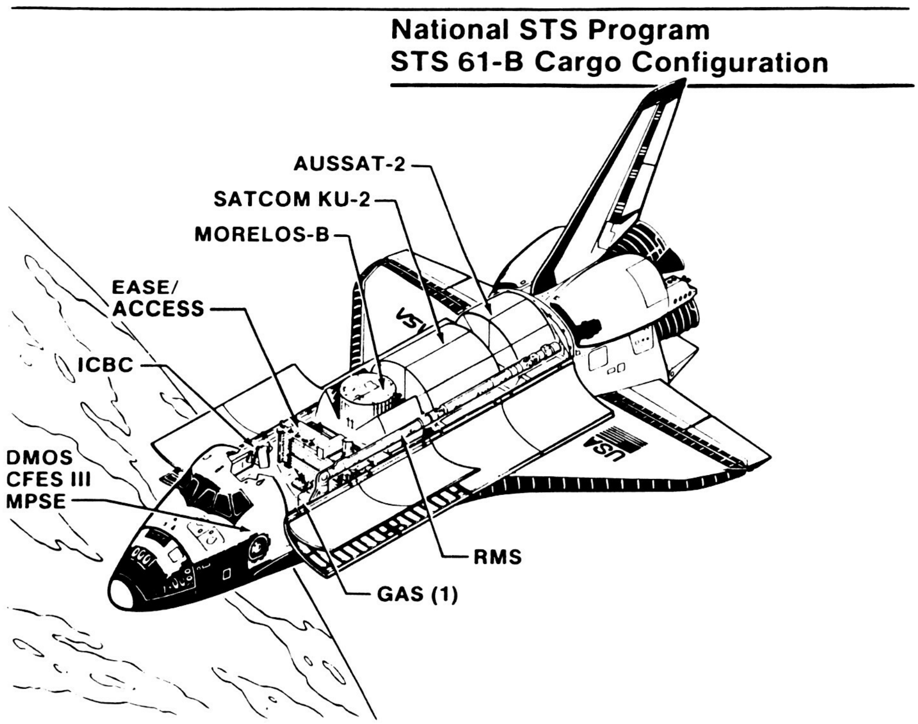


Figure 4

The objective of the meeting was to finalize the previously mentioned details so that all STS 61-B flight documentation would be ready for review at the STS 61-B Flight Operations Review (FOR).

On August 13, 1985, the STS 61-B FOR was conducted to verify the EASE/ACCESS payload technical requirements. The purpose of the FOR was to determine the status of the STS flight operations implementation and to ensure that the training documentation, the JSC Mission Control Center (MCC) configuration, and the STS 61-B operational documentation were ready to support the final phase of training of STS 61-B flight crew and MCC operations support personnel. The basic products used to conduct the FOR and the resulting final products baselined at the FOR are shown in Figure 5.

The STS Flight Readiness Review (FRR) was conducted on November 18, 1985, prior to the launch of the STS 61-B mission. The STS 61-B FRR was conducted to verify that all of the STS/cargo integration activities had been completed and to certify that all flight elements were ready to perform the mission. Before the FRR, the SPPO, the other STS 61-B payload customers, and the STS Centers determined and verified their respective readiness to launch. The FRR is conducted by NASA Headquarters and is supported by all of the NASA STS Centers. The STS 61-B cargo integration/safety assessment was presented at the FRR by personnel from the JSC NSTSO.

MISSION OPERATIONS PROCESS

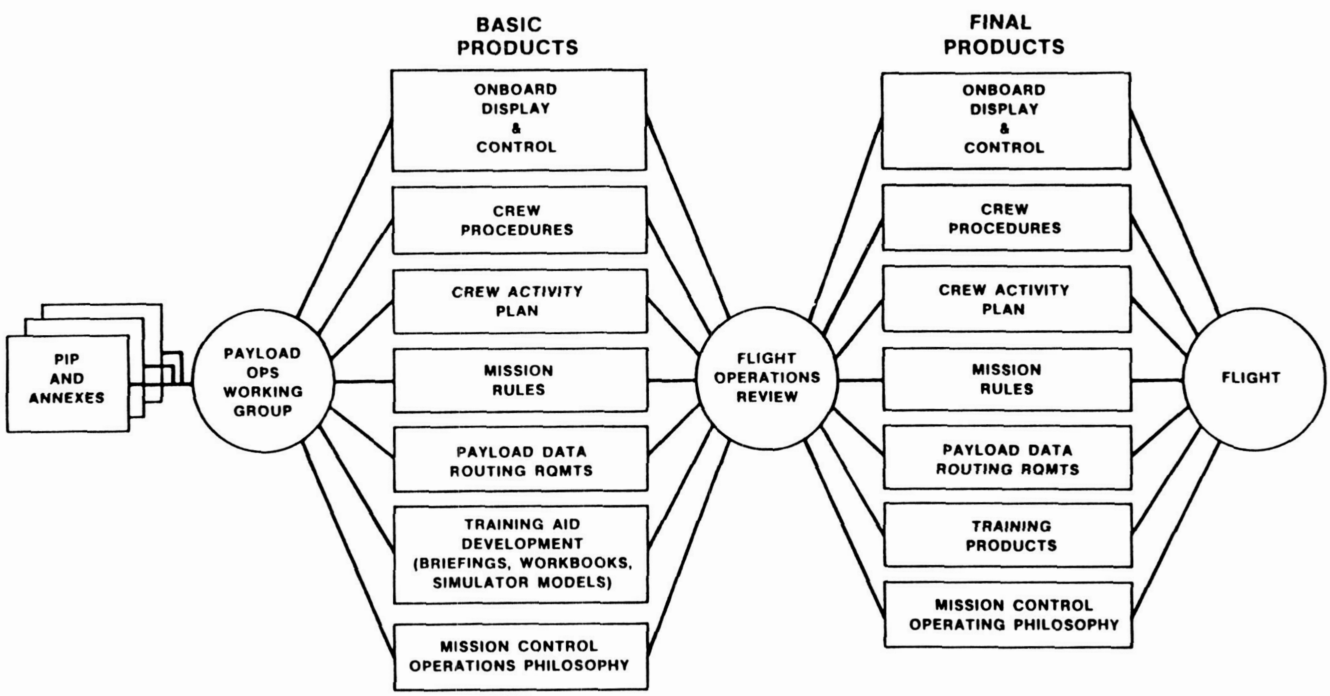
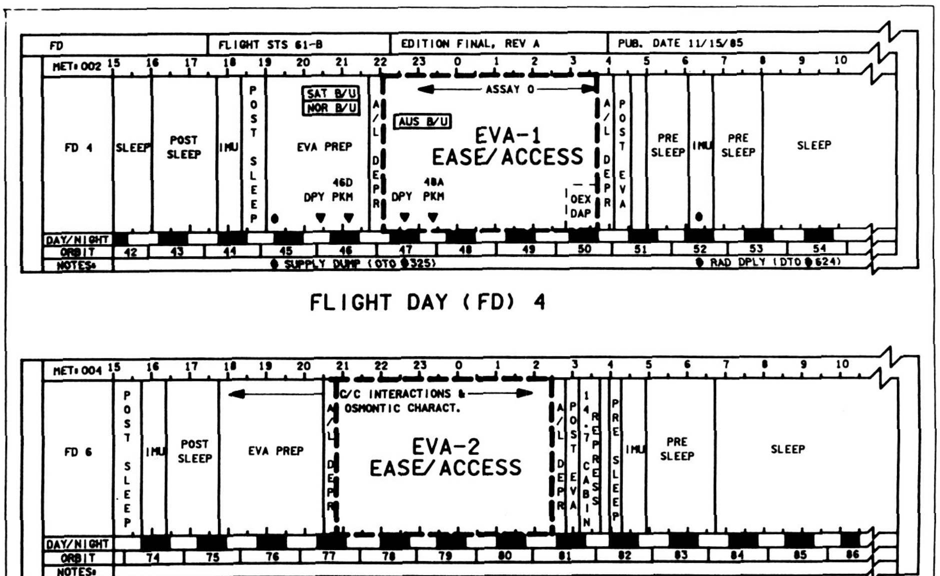


Figure 5

With the approval of the Flight Readiness Review Board to proceed with the planned mission, the launch of the STS 61-B crew and cargo occurred on November 26, 1985, from KSC in Florida and subsequently landed at Edwards Air Force Base, CA, on December 3, 1985. The Space Shuttle Orbiter Atlantis (OV-104) with five NASA astronauts and two payload specialists were launched to accomplish the STS 61-B mission objectives.

Two EVA's dedicated to EASE/ACCESS flight activities were a subset of the planned STS 61-B mission objectives. The first EVA, which occurred on mission flight day 4, had the two NASA EVA mission specialists exercise the EASE/ ACCESS payload hardware in the cargo bay with other NASA crewmembers collecting CCTV and photographic flight data on both the EASE and the ACCESS experiments. The second EVA, occurring on flight day 6, was used to evaluate the existing STS equipment and crew capabilities in carrying out the EASE/ACCESS Space Station Assembly Test DTO 0817. The portion of the STS 61-B mission Crew Activity Plan illustrating the two EVA days is shown in Figure 6. Specific details on both EVA's will be provided by both the experiment principal investigators and the STS 61-B flight crewmembers in other papers and discussions at this conference.

To support the EASE/ACCESS crew activities, in-flight payload support was provided by MSFC SPPO and EASE/ACCESS experiment management and technical personnel located in the JSC Customer Support Room (CSR) and in the MSFC Huntsville Operations Support Center (HOSC). Special communication tie-lines were provided to the EASE/ACCESS team during the mission between the JSC CSR and the MSFC HOSC to permit access to additional technical support at the MSFC HOSC. Besides the standard communication loops available in the CSR, a special communication loop was established to permit direct



FLIGHT DAY (FD) 4

FLIGHT DAY (FD) 6

Figure 6

discussions between the EASE/ACCESS management and technical team and the STS 61-B EVA officer. This EVA officer communication loop was of special importance during the mission to discuss EASE/ACCESS problems such as the failure of the EVA crewmembers to secure one of the two closure latches on an ACCESS equipment container and the difficulty the EVA crewmembers experienced when the EASE tetrahedral cell could not be refitted to the attachment node that secured the EASE cell to the payload carrier.

CONCLUSION

The EASE/ACCESS payload science objectives and the EASE/ACCESS Space Station Assembly Test Objective (DTO 0817) were fully achieved during both of the STS 61-B mission EVA's by the NASA crewmembers. The precision with which all of the participating crewmembers carried out their assigned duties was according to all of the prescribed mission documentation. In general, the mission went extremely well with the flight crew at times being well ahead of their planned mission timeline. The flight crewmembers proved once again that suited EVA crewmembers can do reasonably complex assembly tasks in space.